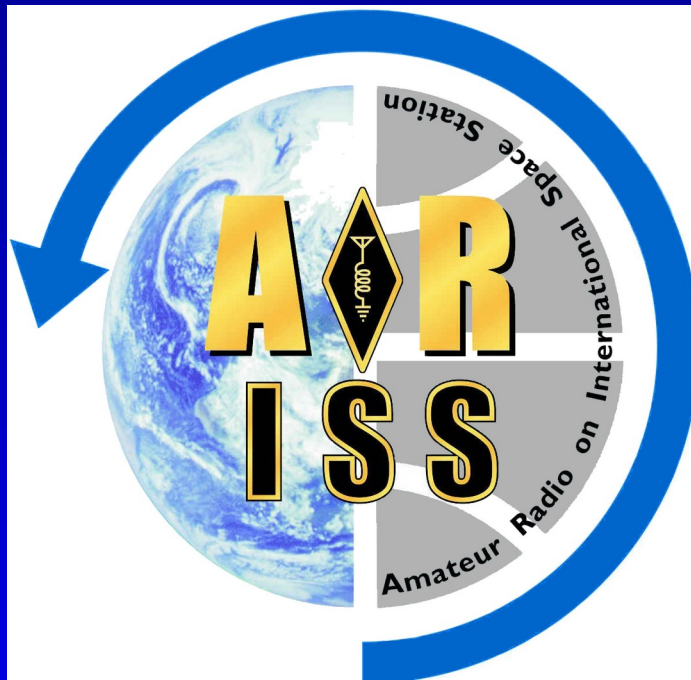


Amateur Radio On The International Space Station (ARISS) Status & Future Plans



Status
April, 2002

Frank H. Bauer, ka3hdo@amsat.org
Will Marchant, kc6rol@amsat.org
Lou McFadin, w5did@amsat.org

Amateur Radio on Human Spaceflight Missions

*Since 1983, organizations in the U.S.
(SAREX), Germany (SAFEX) and Russia
(MIREX), have worked with the space
agencies to fly amateur radio and to support
Educational Outreach on:*



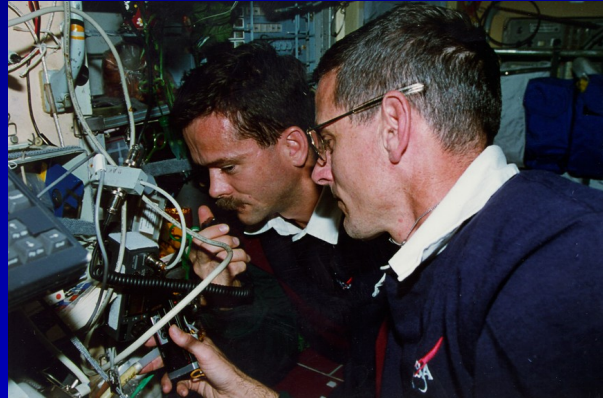
Space Shuttle

ISS



Mir

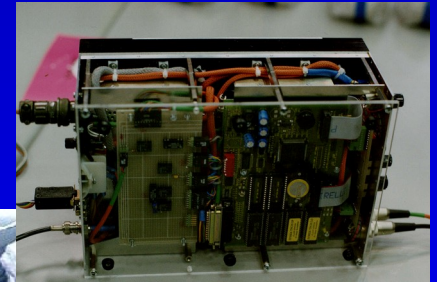
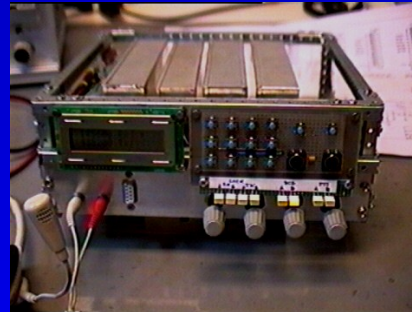
ARISS Objectives



Spark Student's Interest In Science & Technology
Crew Family Contact
Promote Interest In Amateur Radio
Crew Psychological Operations



Human
Spaceflight



Experimentation

Development & Operations on the International Space Station (ISS)

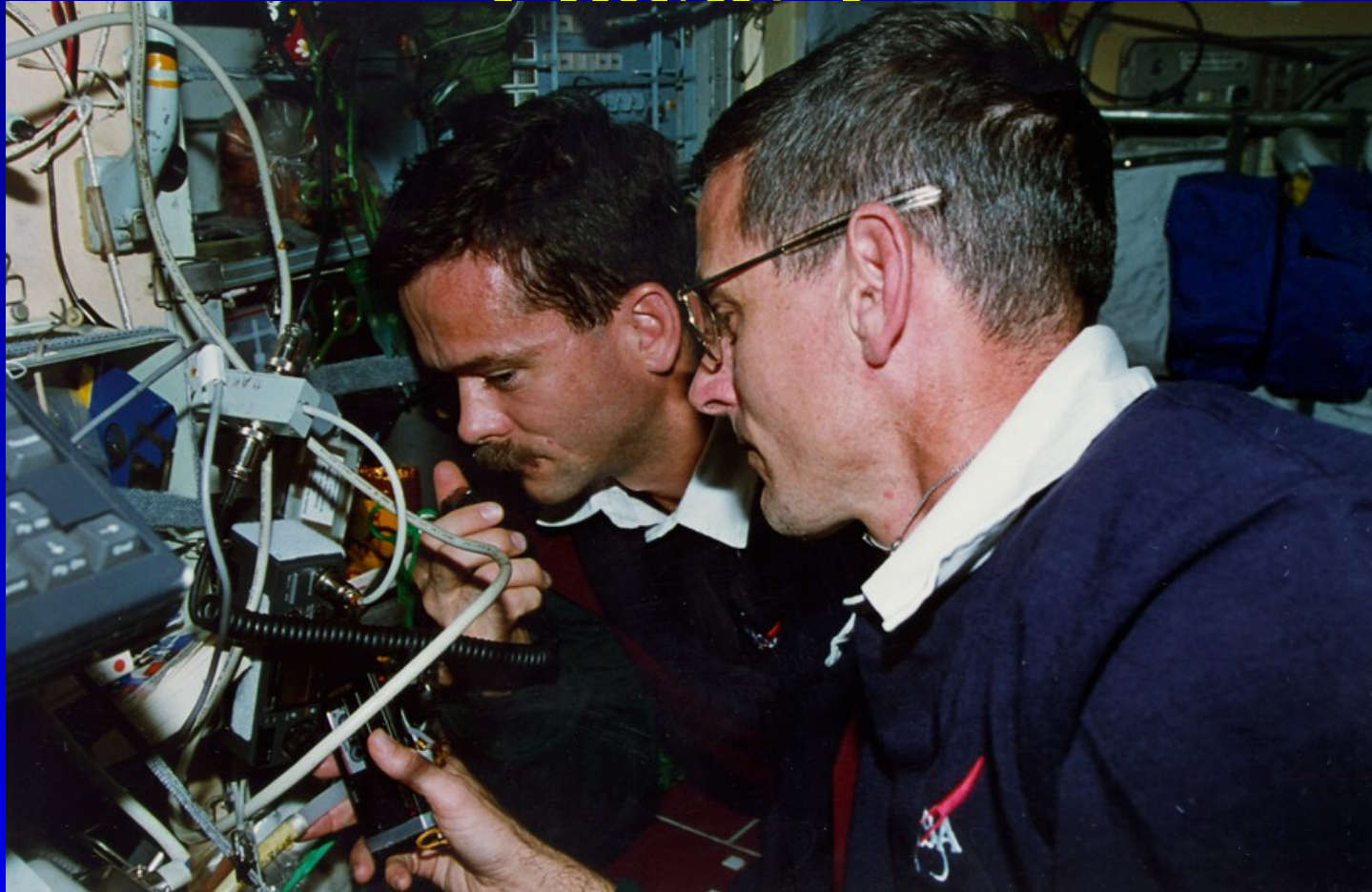
Working with our international partners to develop & operate Amateur Radio on the International Space Station (ARISS)

ARISS Organization

- Nine international partners thus far—Belgium, Canada, France, Germany, Italy, Netherlands, Japan, Russia and United States
- MOU—Formed ARISS to represent the amateur radio community to the ISS Program
- Rules & Bylaws developed with delegates from Europe (4), America (4), Russia (2) and Japan (2)



Planned Capabilities for Initial Station ISS Ham Phase 1



2-way voice

Planned Capabilities for Initial Station ISS Ham Phase 1 (Continued)

Posted : 06/28/97 17:58

To : ALL

From : ROMIR

Subject: Mir Status

Computer -to- Computer Radio Links

Amateur Radio
E-mail from
Mike Foale
after Progress
collision with
Mir Spektr
Module

We have now got the base block, the module Kvant 2 back on line, leaving 2 more modules. Working very hard, lights in our mouths, in the dark, moving batteries about, to enable better charging, with solar arrays. O2 electrolysis soon, in old Kvant. Much interest from control center to do internal eva to reconnect power to lost Spkektr module, to receive its substantial electrical power from its large arrays.

Thanks for all your good wishes. Mike.

Planned Capabilities for Initial Station ISS Ham Phase 2



DigiTalker
(Voice Repeater)

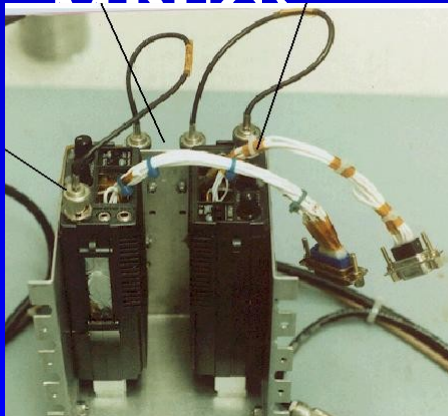


Slow Scan TV
(Photos/JPEG Images)

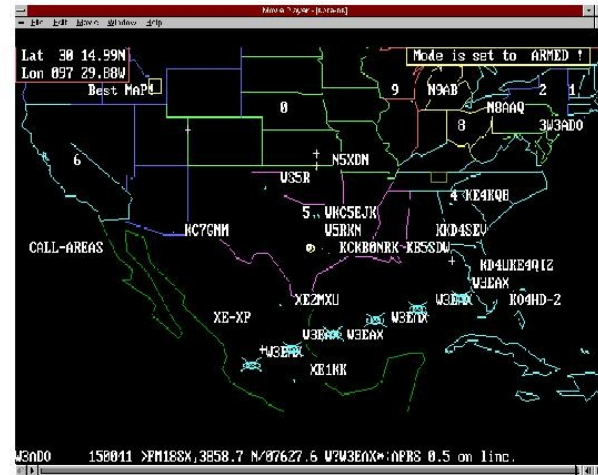
Future Capabilities



Amateur TV
(Standard, Spread
spectrum, &
MPFS)



SPRE Pass Over U.S.



R/T Internet TLM
using amateur
radio
Express
Pallet---
External
payloads w/

EQUIPMENT DEVELOPMENT PLANS

**Development will be conducted in four ISS
phases :**

- **Initial Amateur Station (Part 1 on-orbit)**
- **Transportable Amateur Station
(Developing)**
- **Permanent Amateur Station (Future)**
- **Express Pallet Experiments (Future)**

Initial Amateur Station Part 1

- **Improved Packet Module (Computer-to Computer Radio Link) (U.S. Built)**
- **Ericsson VHF Radio & UHF Radio for Voice ops (U.S. Built)**

Qualified & On-Board ISS!

- **Multi-band Antennas (Italian, U.S. & Russian Built)**

Qualified & On-Board ISS!

Initial Amateur Station Part 2

- **Digitaler/Speaker-Mic (German Built)**
- **SSTV (U.S. Built)**

ARISS Equipment Installation History

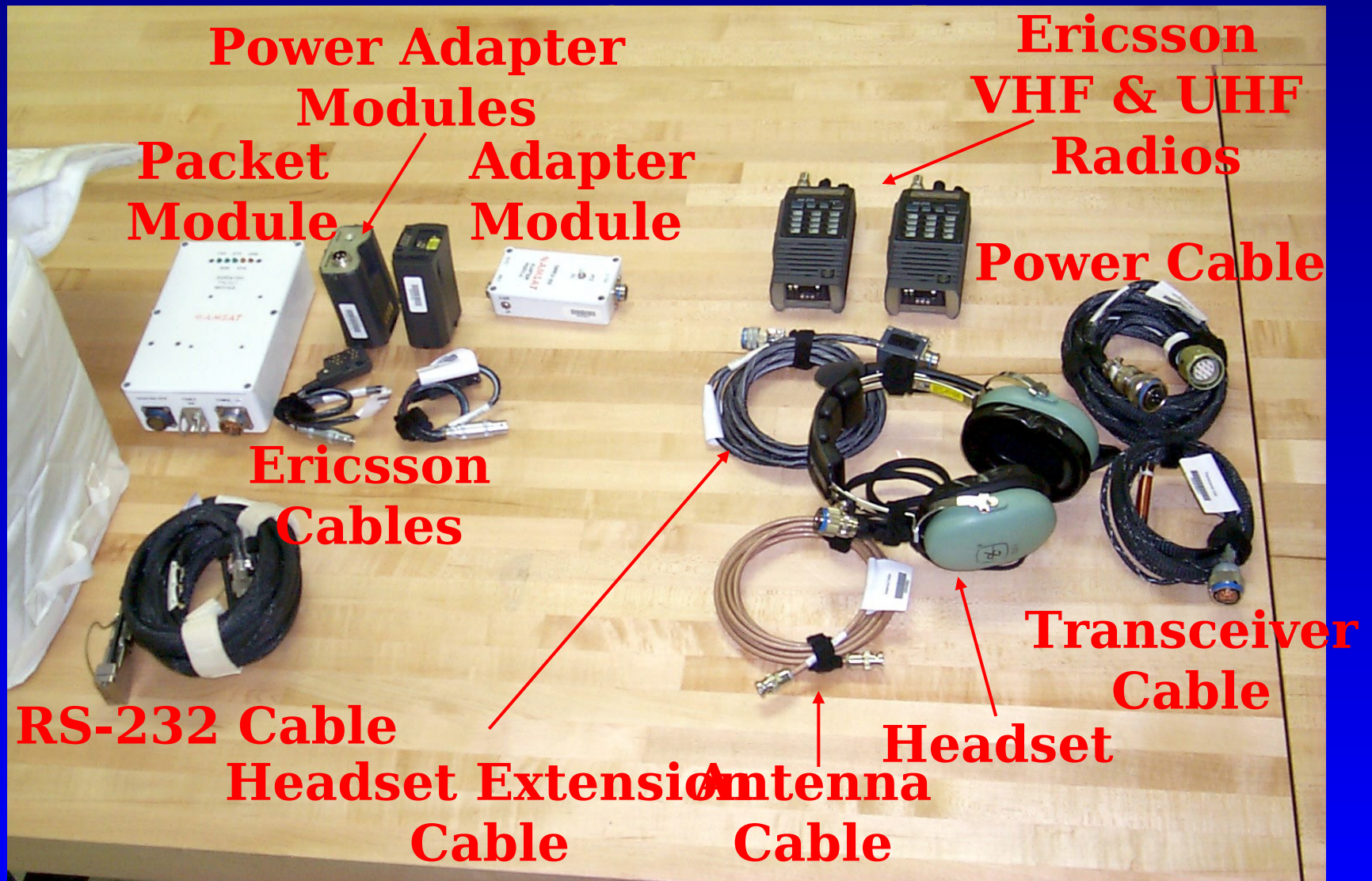
- Service Module
 - Docking with ISS completed on July 25, 2000.
 - four module penetrations allocated for amateur radio use.
 - feedthroughs shared with EVA video system.
- STS-106 (2A.2B)
 - September 8, 2000
 - delivered internally installed hardware to ISS
 - initially installed in Zarya (FGB) & attached to Sirius antenna system for VHF (2 meter) operation
- Soyuz Flight 2R
 - October 31, 2000--Increment 1 crew launch
 - Increment 1 crew activates equipment and school group contacts begin on November 13, 2000

Initial Amateur Station Part 1

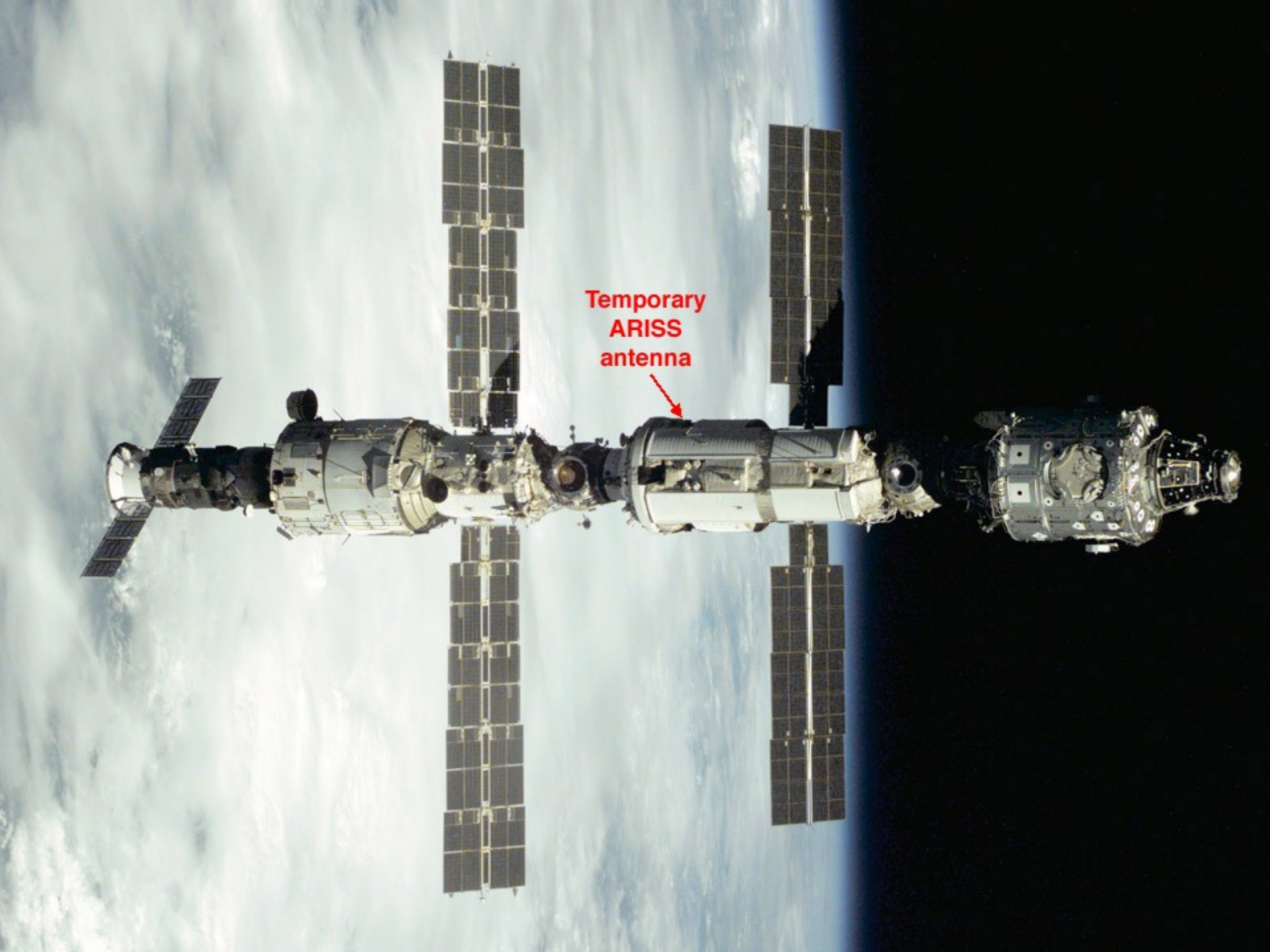


Initial Amateur Radio Station Undergoing EMI Tests at GSF

ARISS Provided Hardware to ISS HAM

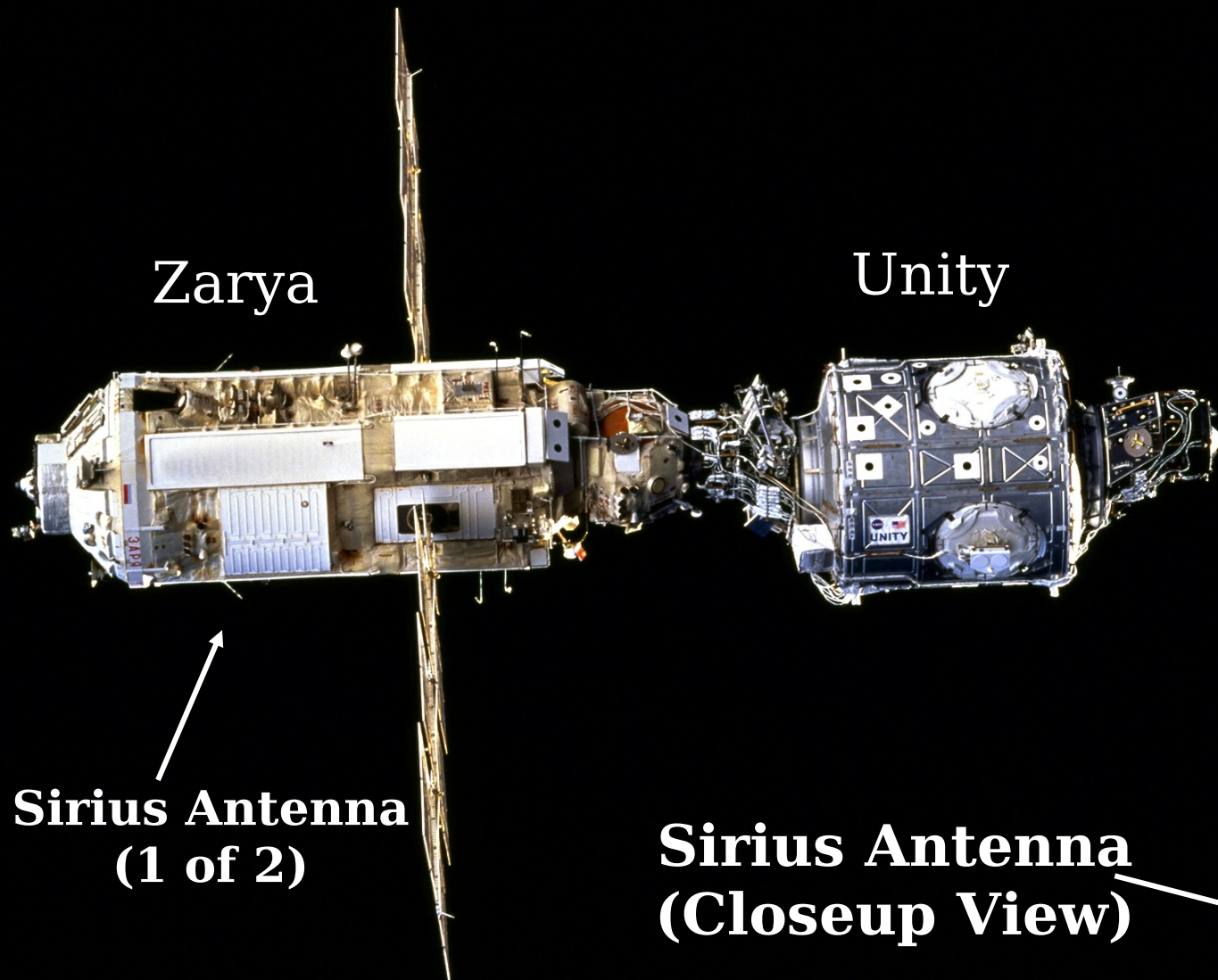






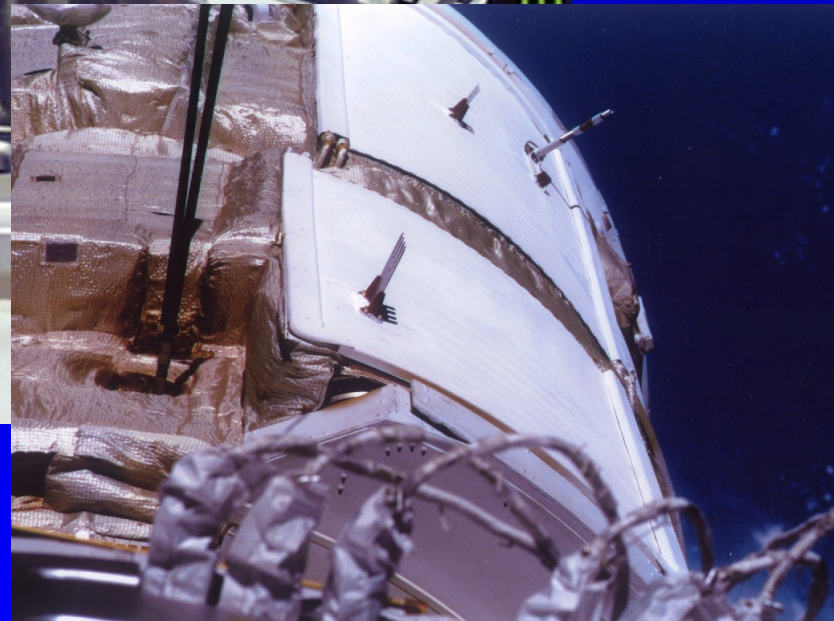
Temporary
ARISS
antenna

SIRIUS ANTENNA LOCATION ON ZARYA



Sirius Antenna
(Closeup View)







Near Term Schedule—Phase 1

- STS-105 (7.a.1) August 2001
 - Delivered new packet module on orbit
 - Eliminates nocall/dead battery issue
 - Supports simultaneous 2 radio ops in FGB & Service Module
- STS-108 (UF-1) December 2001
 - Delivered 4 antenna systems to ISS
 - Delivered adapter module & add'l cables to support 2 radio ops to ISS
- Expedition 4 & 5 crews
 - Install antennas during Extra Vehicular Activities (EVAs)
 - Install 70 cm radio system in Service Module
- STS-TBD (Manifesting Request Pending—late-2002 to early 2003)
 - Deliver SSTV hardware to ISS





AMSAT NA

ПАКЕТНЫЙ МОДУЛЬ
PACKET MODULE

РАДИО СТ.
RADIO

РАДИО СТ.
RADIO

ВКЛ ПИТ
POWER ON

ВКЛ ПИТ
POWER ON

ВХОД ПИТ
POWER IN

ВХОД ПИТ
POWER IN

Packet Module Bench Review

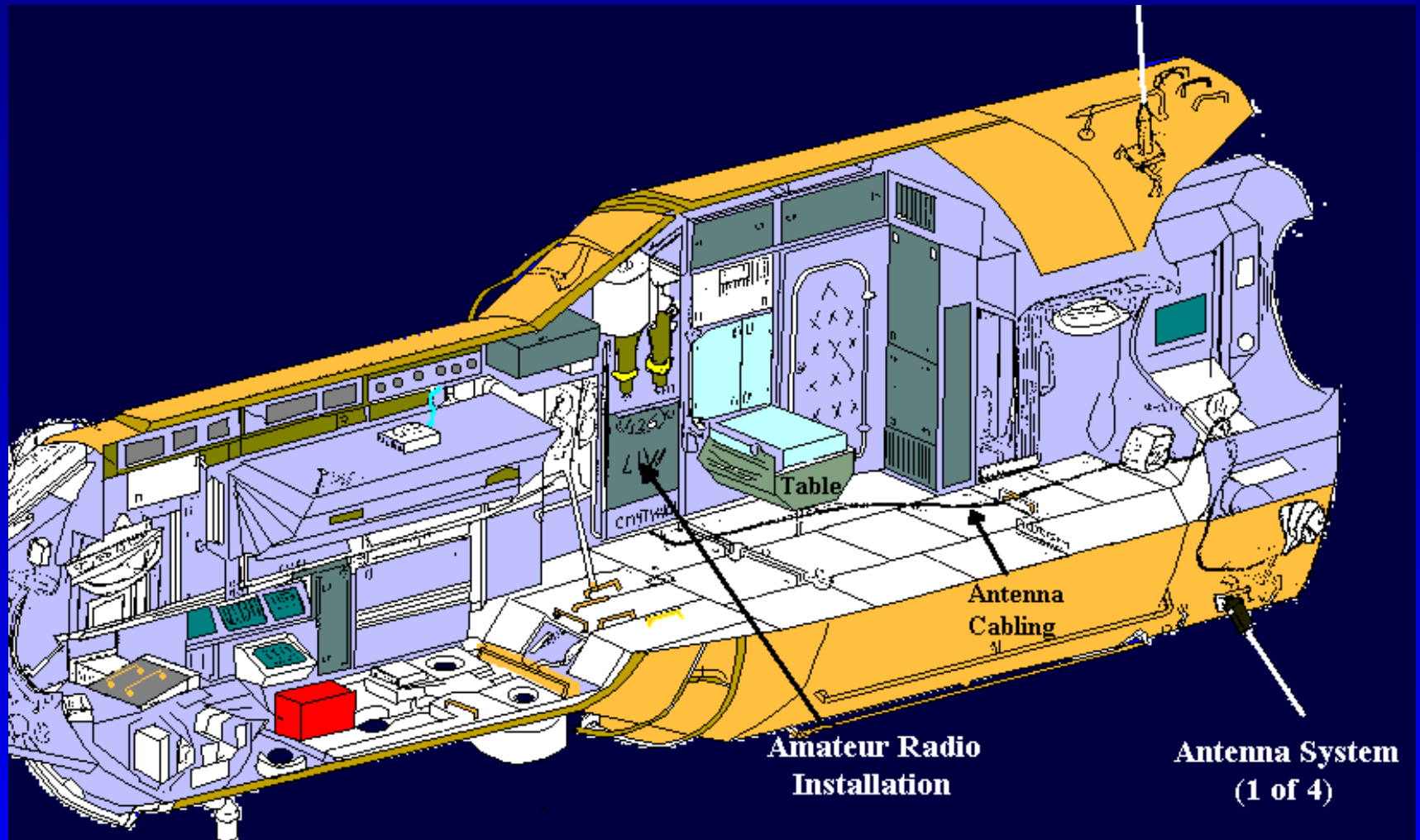


Service Module and FGB



ARISS / ISS HAM

Location in and on the Service Module

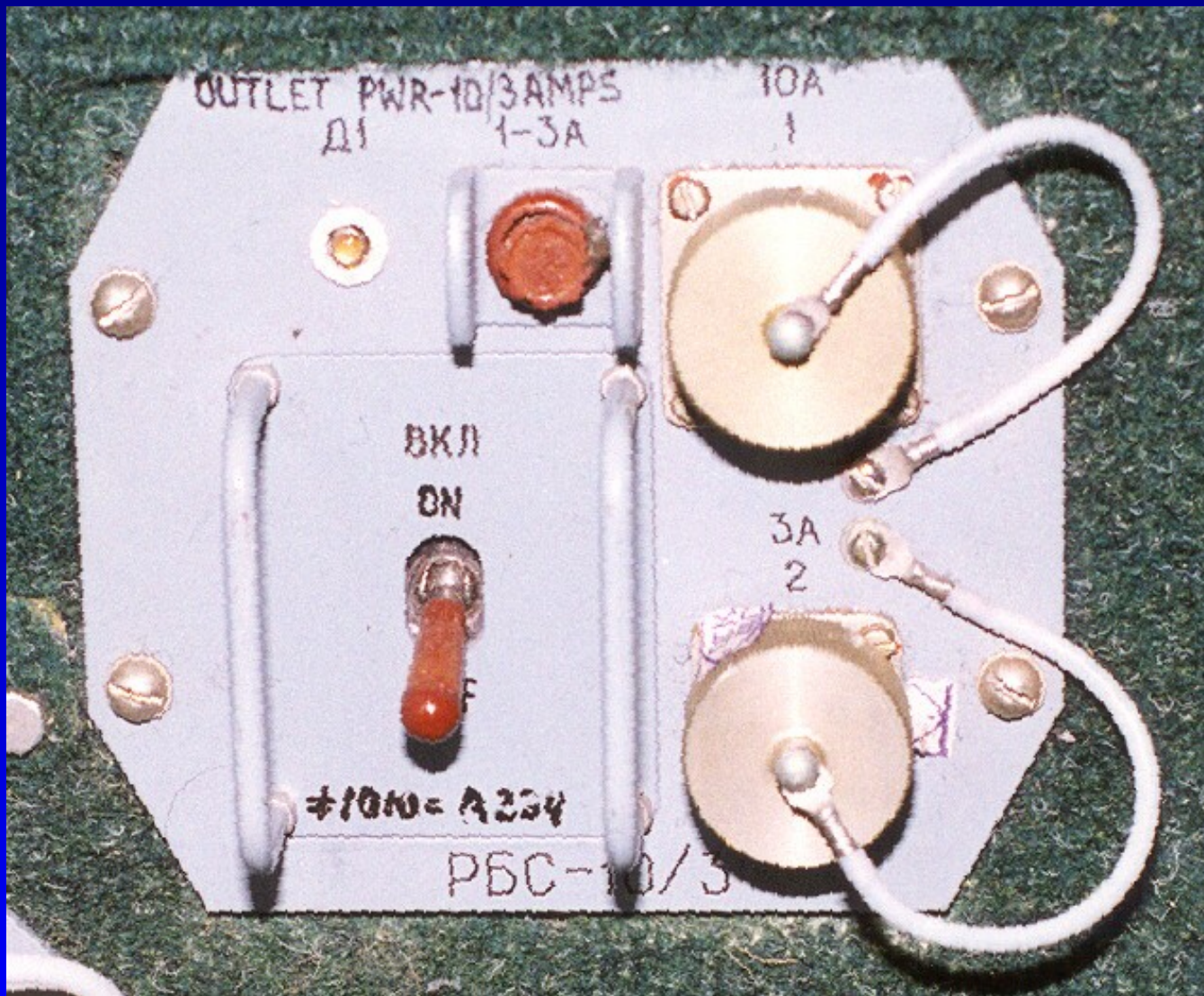


ARISS Hardware Location in Service Module



ARISS Team Members Sergej Samburov (Russia), Frank Bauer (US) & Alberto Zagni (Italy) (L to R) in front of ARISS Hardware Installation Area

Switchable 10 A Russian Power Outlet



Service Module Closeout Photos

Radio Station Location



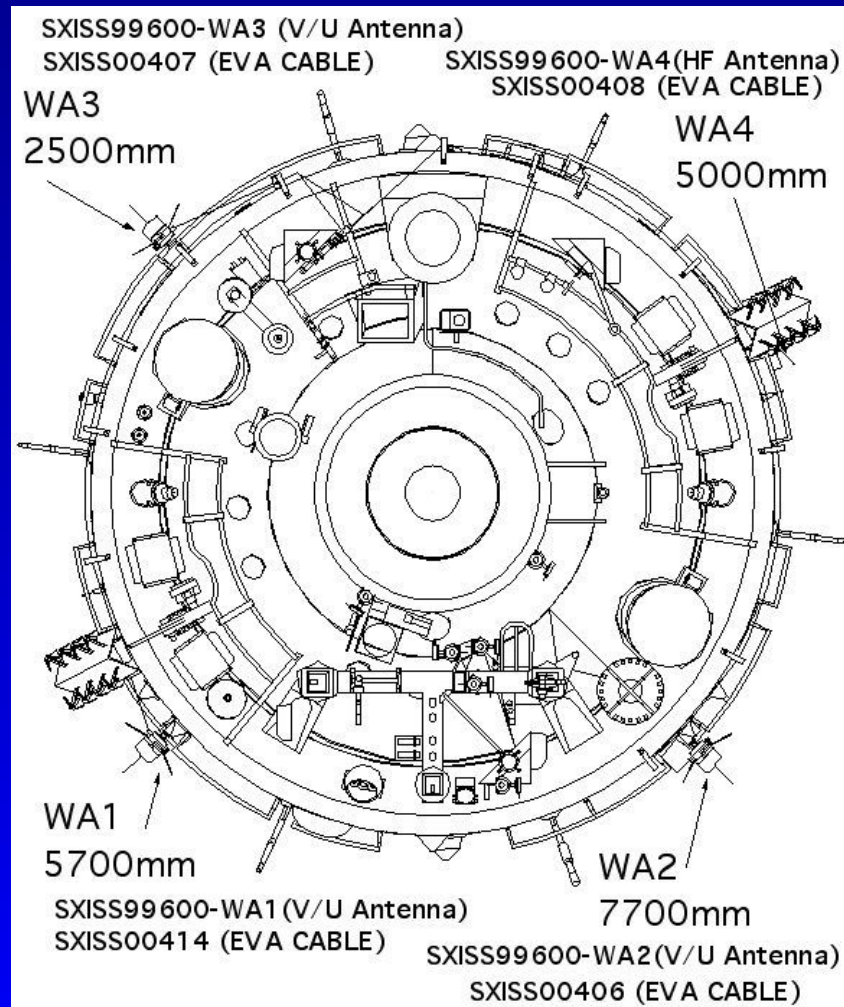
Internal Hardware

(New Item Introduced per Energia's Request)



ISS Ham RF Interface Cable

Antenna System Installation on Service Module



Service Module and FGB



Antenna Systems WA1-WA4



Antenna System w/ VHF/UHF Antenna Installed (1 of 4)

Internationally Developed

Italian Contribution:

Microwave Antennas

Diplexer

US Contribution:

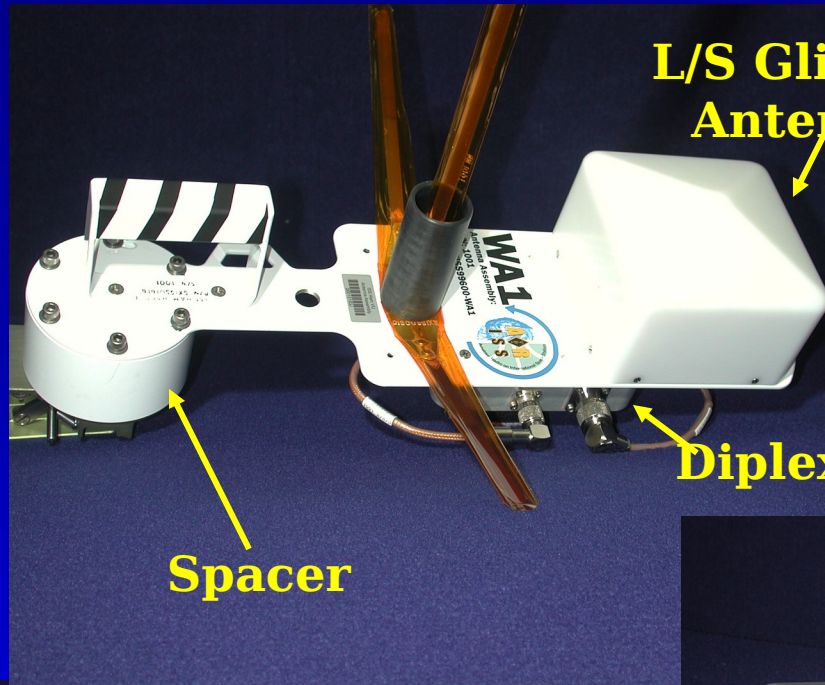
Mounting Plate

VHF/UHF Antenna

Russian Contribution:

Handrail Clamp

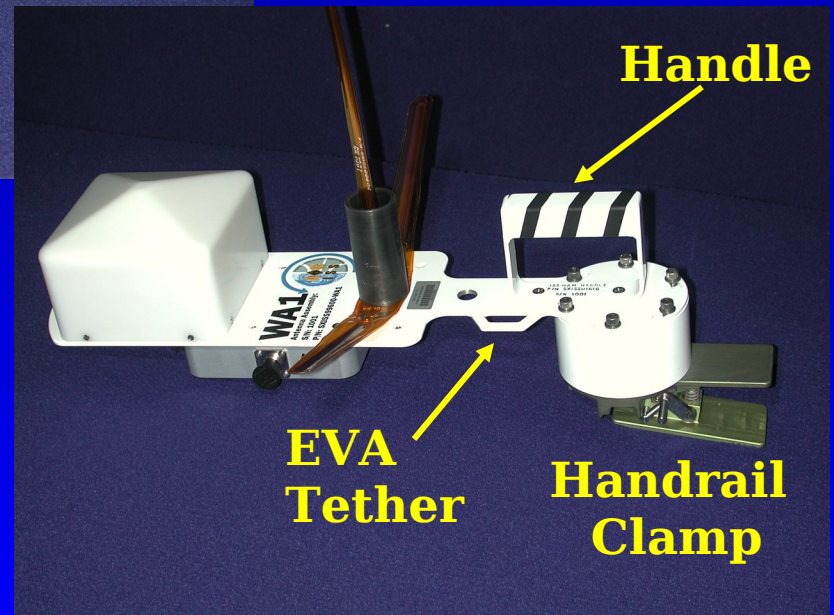
Interconnecting Cables



**L/S Glissier
Antenna**

Diplexer

Spacer



Handle

**EVA
Tether**

**Handrail
Clamp**

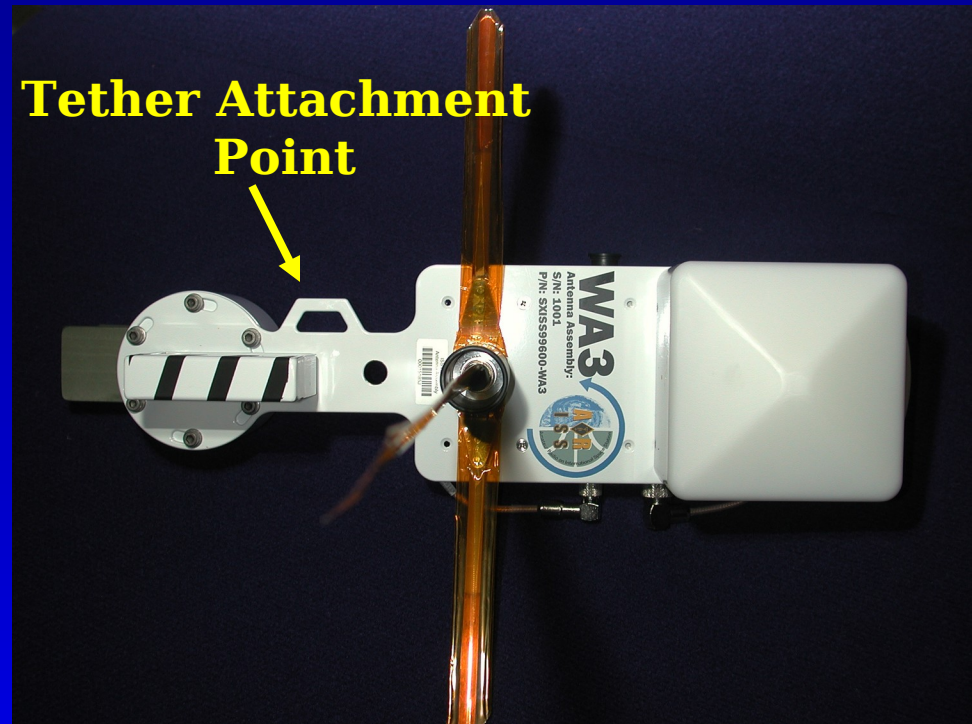
**Tuning
Stubs**

**VHF/UHF
Antenna**

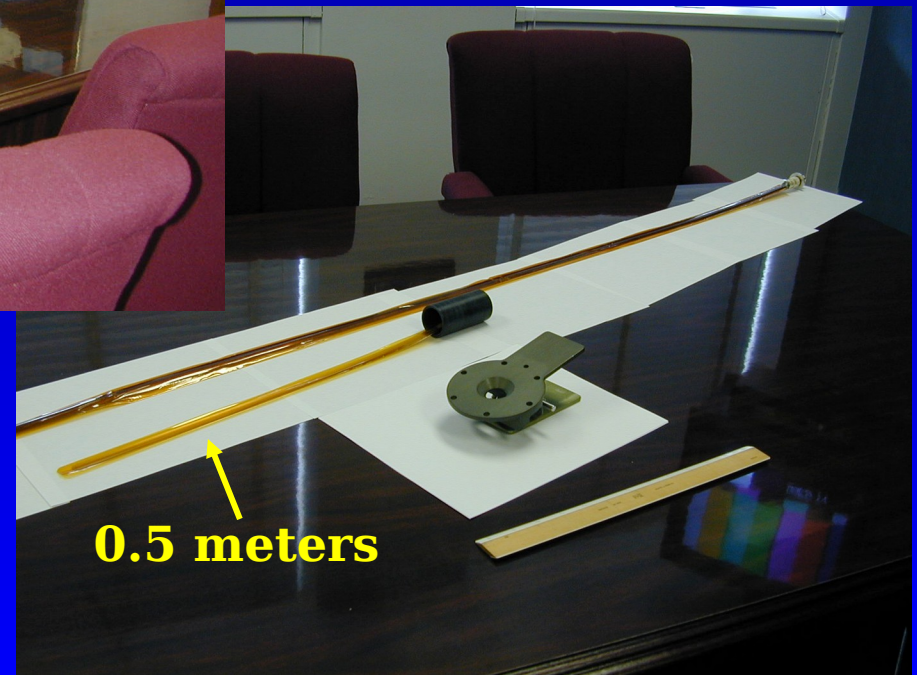
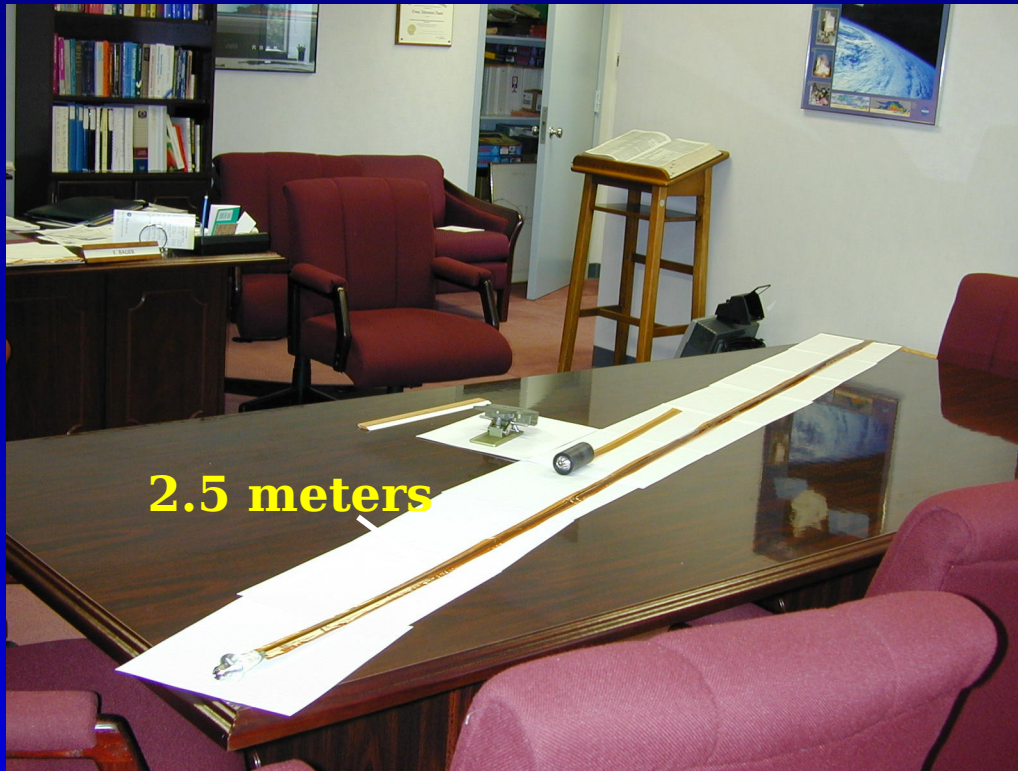
**Mountin
g**

Tether Attachment Point

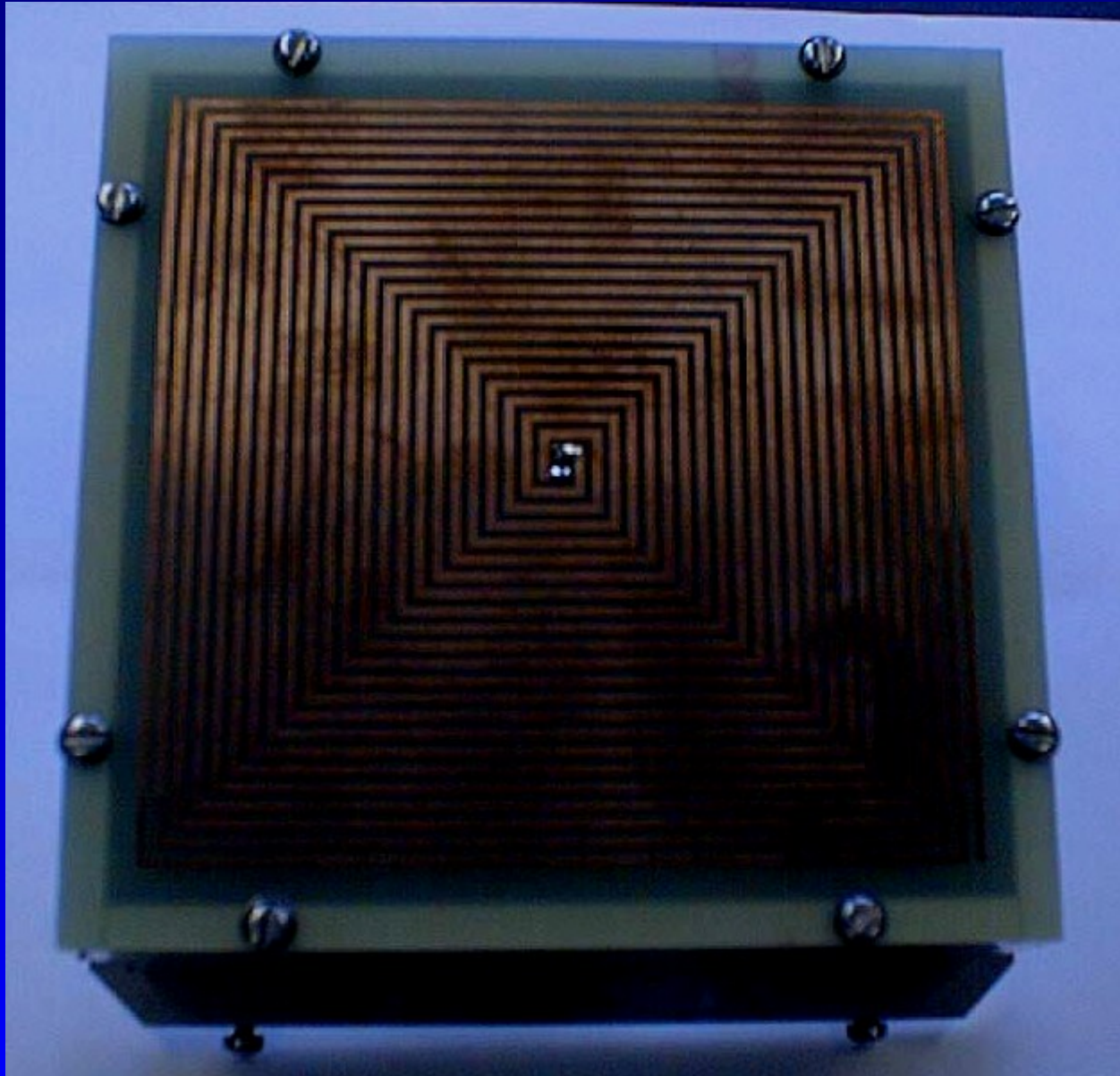
- Test successfully performed on 3/14/01 to validate that Russian & U.S. tether hooks attach to plate tether attachment point
- Test performed by Ed Svrcek/XA & Gary Wright SR&QA of JSC



VHF/UHF & HF Antenna Systems

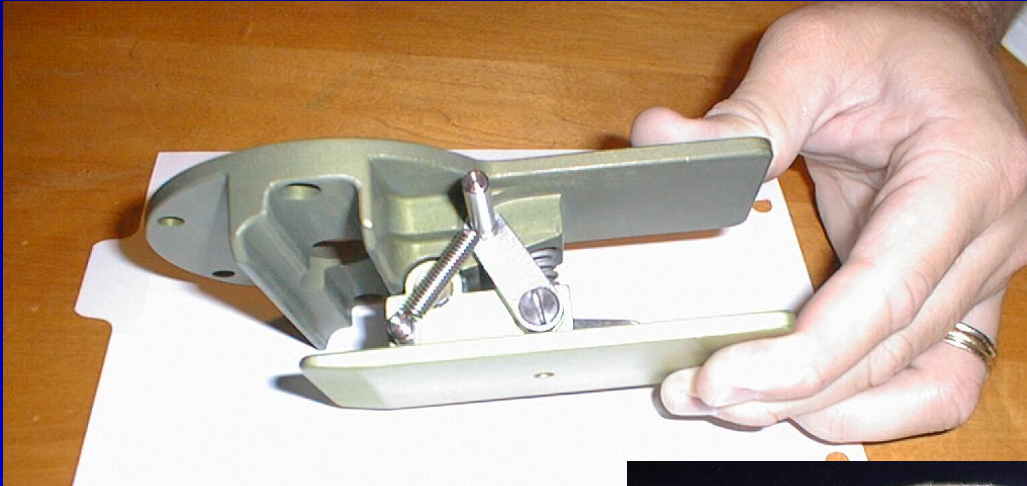


L/S Band Antenna Prototype



Russian Sub-components

Handrail Clamp



Power Connector (Internal)

ISS Ham EVA Cable (w/ EVA RF Interface Connector Attached)



EVA Connector

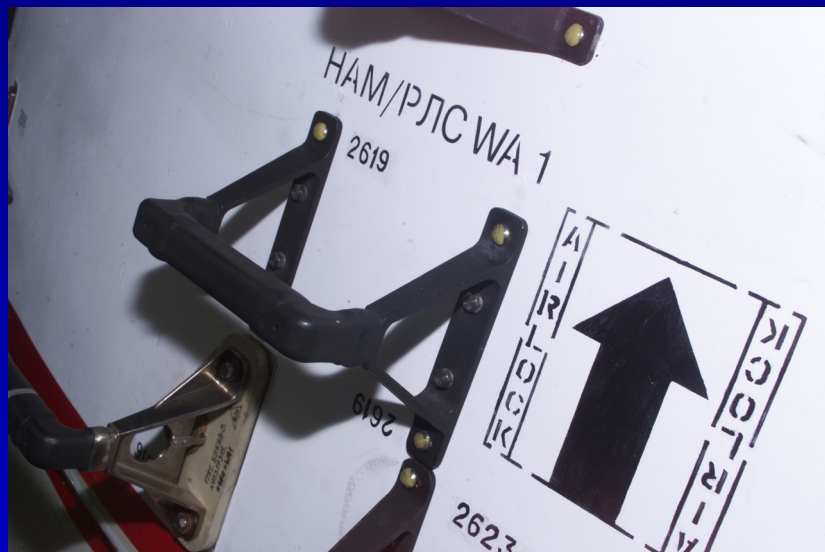


Service Module Closeout Photos

EVA Connectors

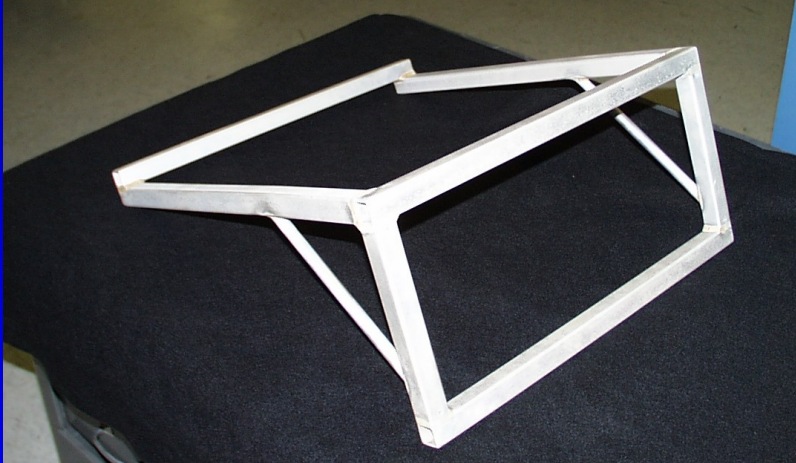


Antenna Handrail Closeout Photos



ISS Ham Antenna Frame

- Considered an EVA tool
- Certification and Acceptance Requirements Document (CARD)



Flight Frame



**Frame Mockup for
Hydrolab Training**

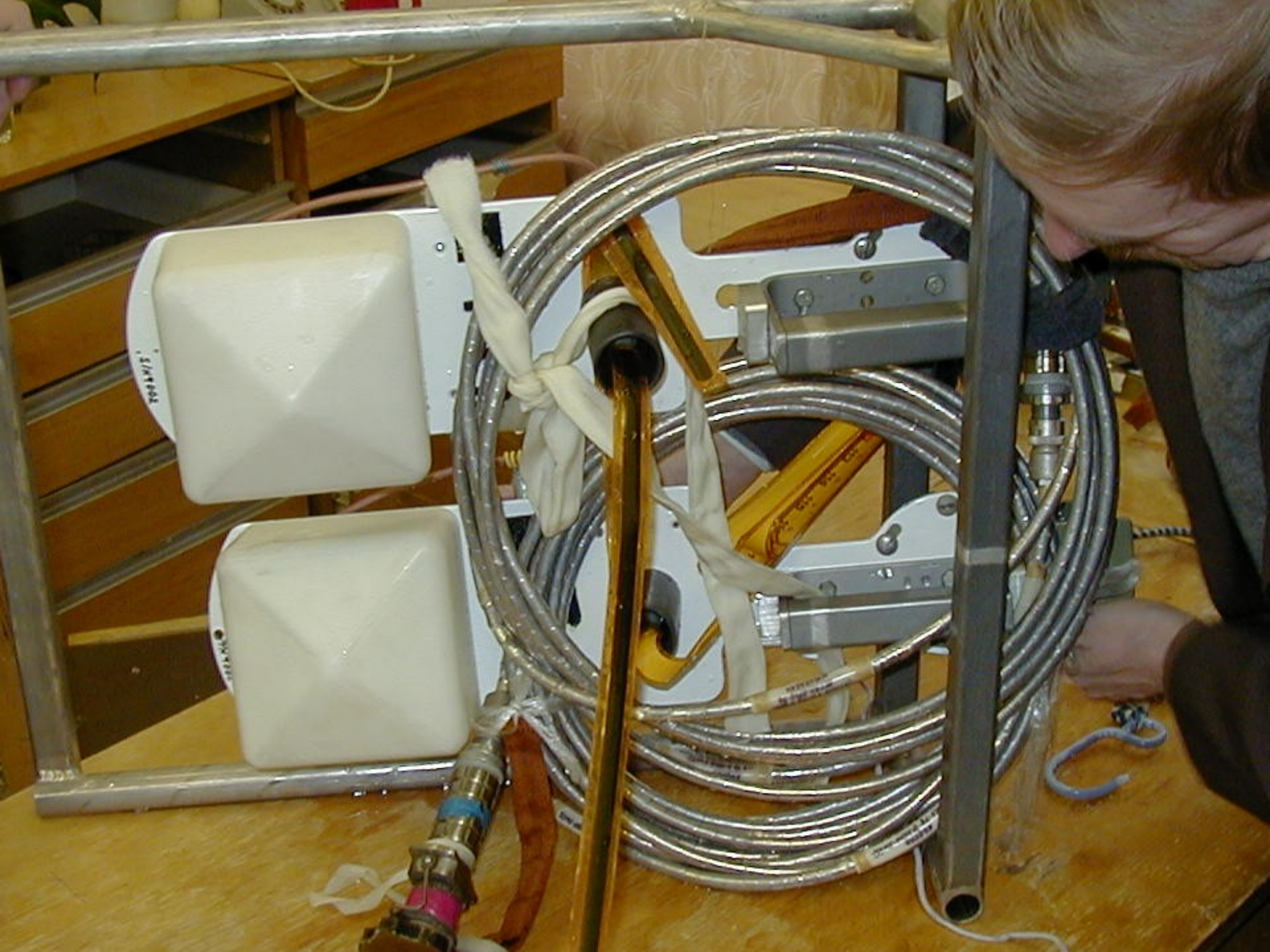
Antenna System Status & Installation Plans

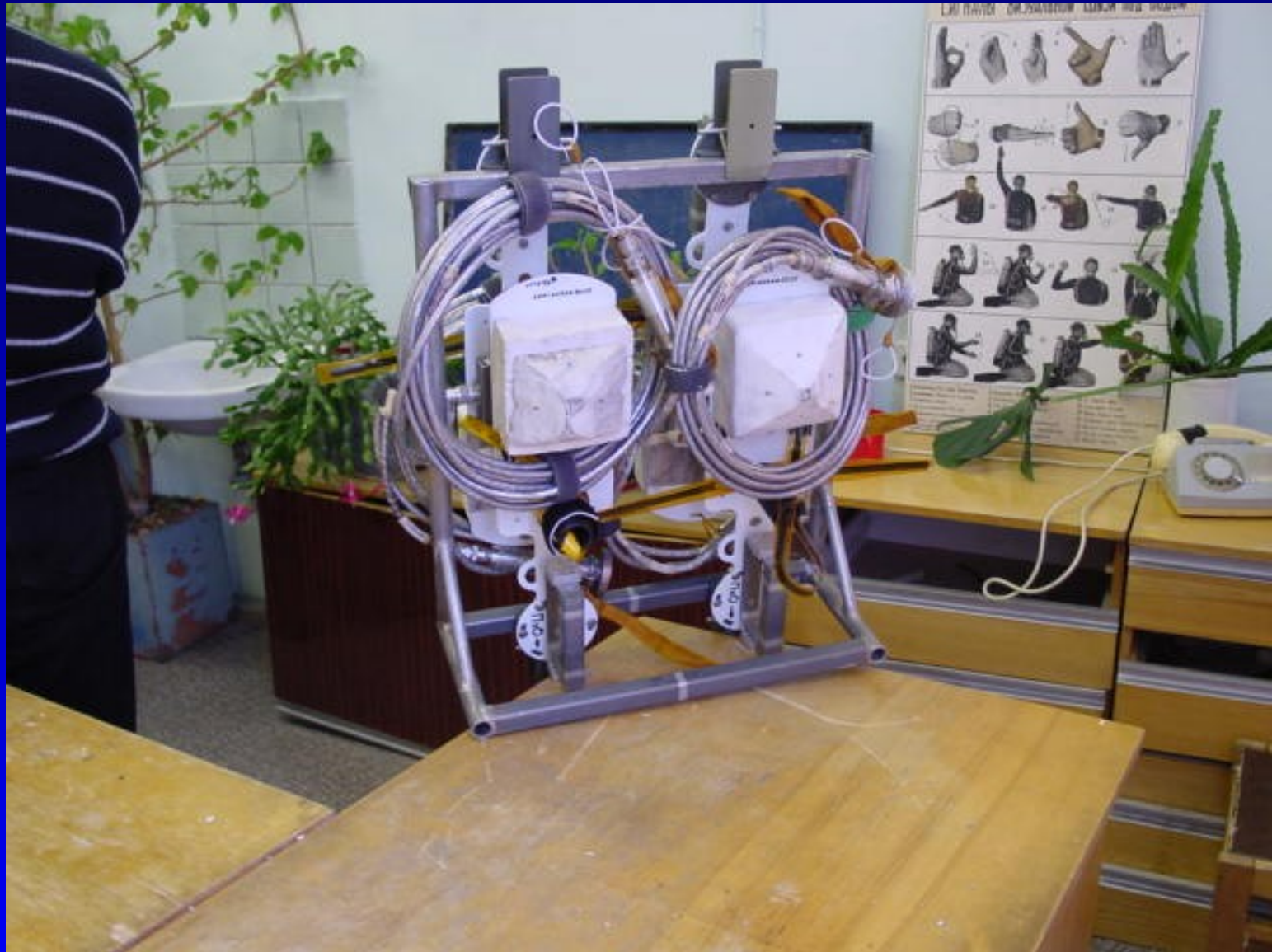
- U.S. team delivered 4 flight validated antenna systems and EVA frame to NASA on September 6, 2001
- Above flown on STS-108 UF-1 flight in December 2001
- Russian team to delivered cable attachment clips & EVA velcro straps by Progress
- Expedition 4 crew installed WA3 antenna on January 14 & WA4 antenna (HF) on January 25
- Two remaining antennas to be installed by Expedition 5 crew (May-December 2002)

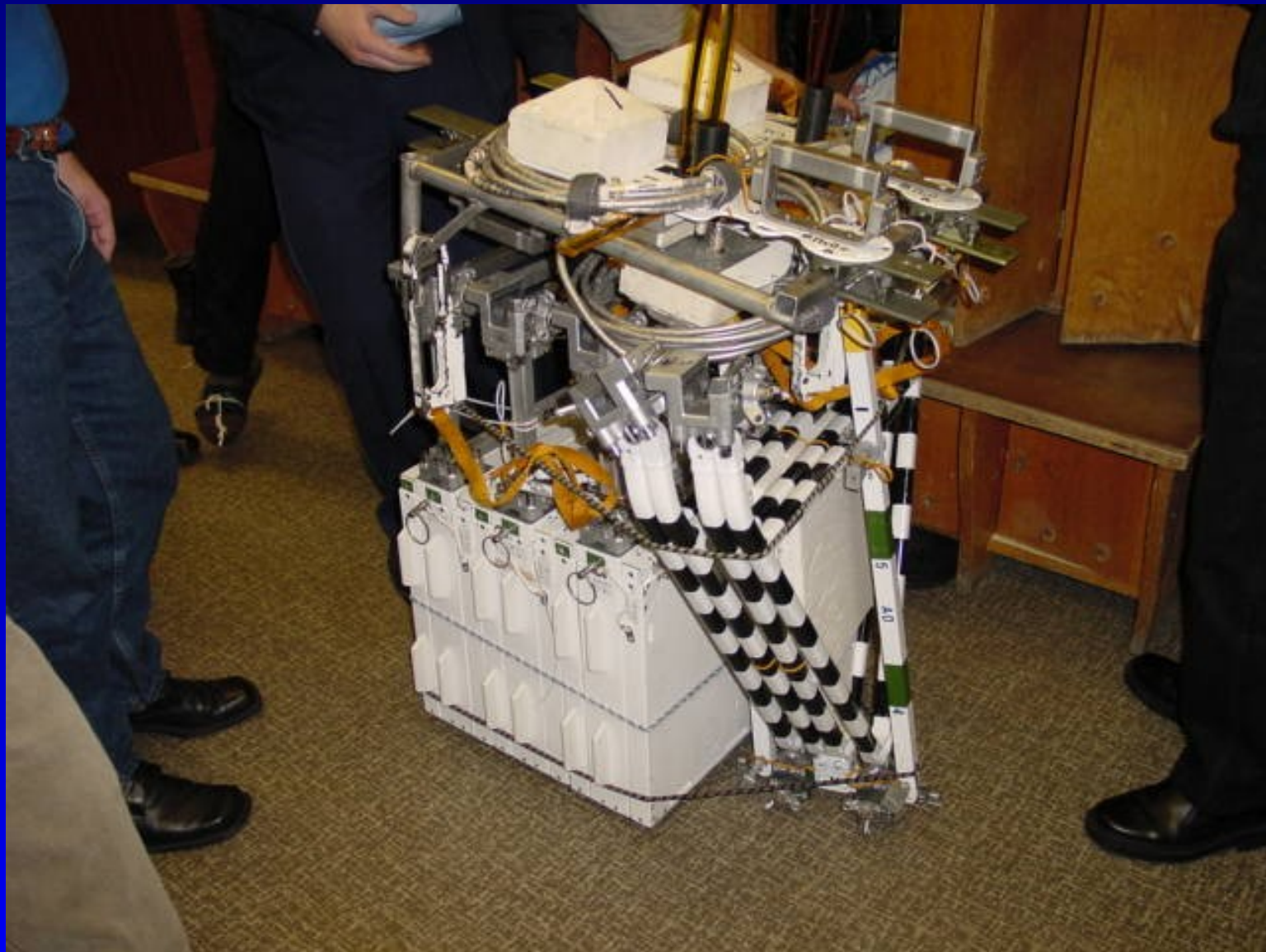
EVA Operations

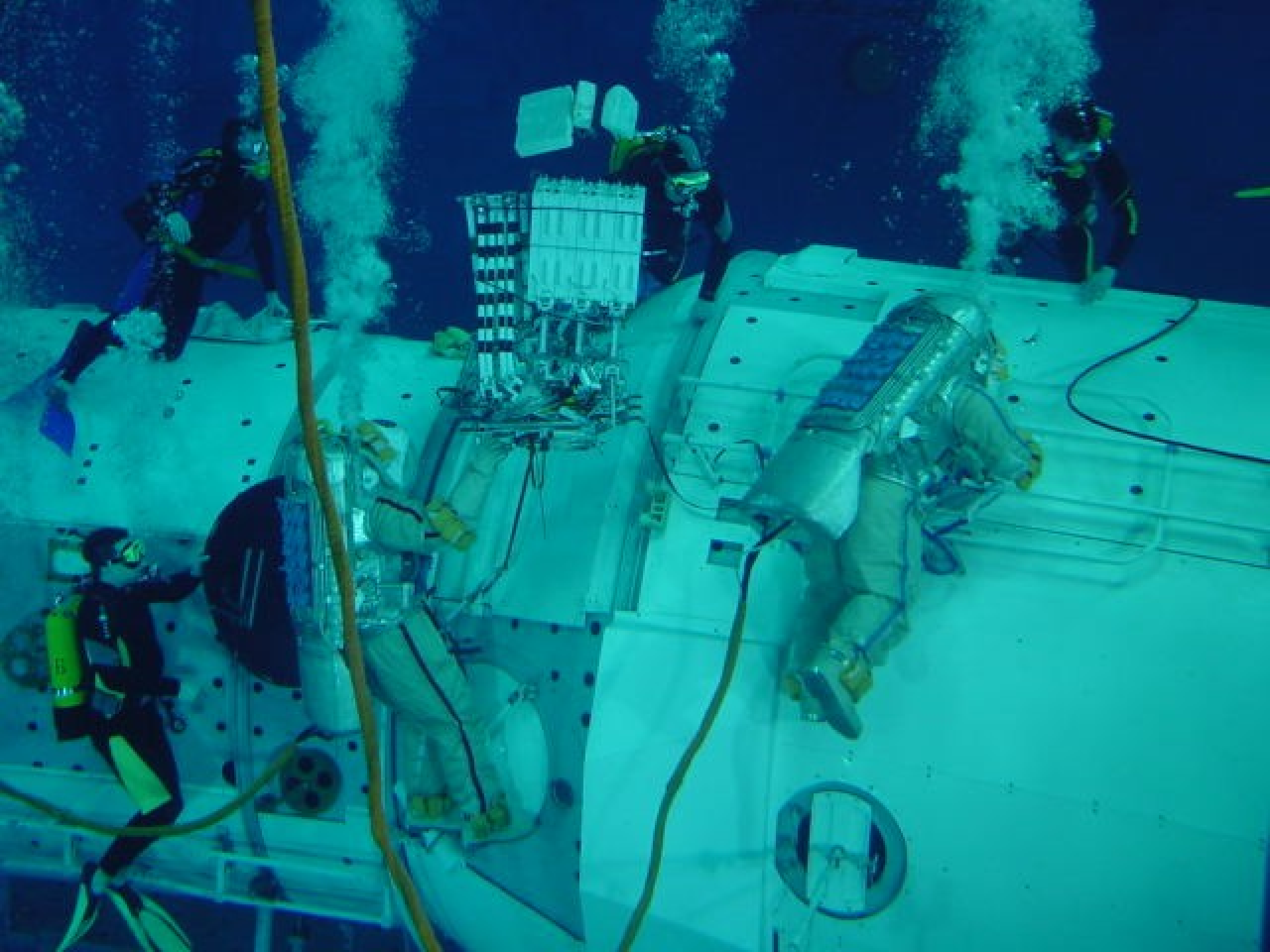
Top-level plan

- Pre-EVA Activities:
 - Use velcro to “segment” each loop of EVA cable
 - Interface EVA Cable to diplexer
 - Using clamp, attach antenna systems to frame or spacesuit
- EVA Activities:
 - Traverse along SM to location of EVA RF Connectors
 - Fasten each antenna system to each handrail & lock in place
 - Deploy and tie-down EVA cable as each antenna system is routed to the specifically depicted handrail
 - Attach RF connectors for WA1-WA4



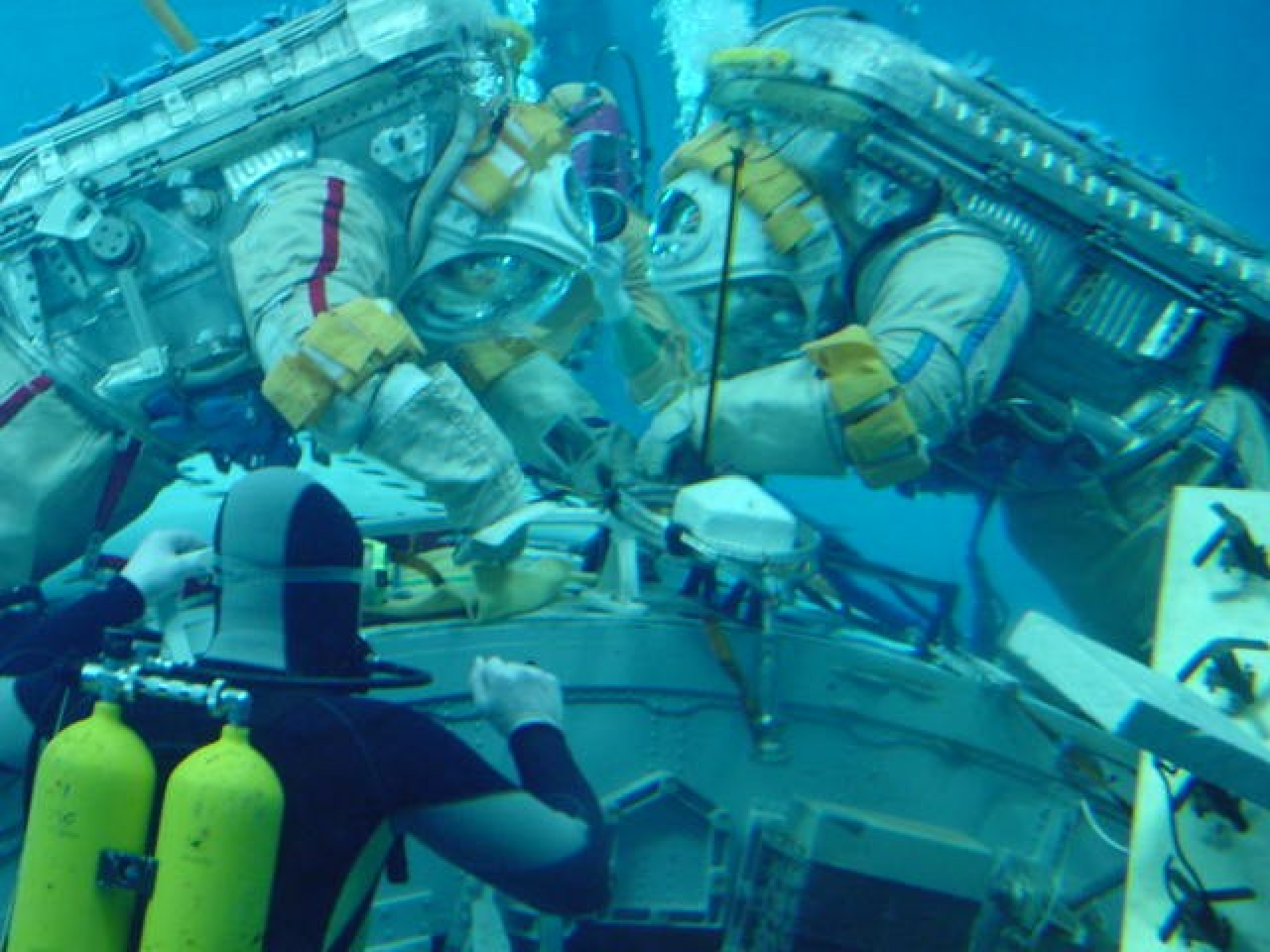










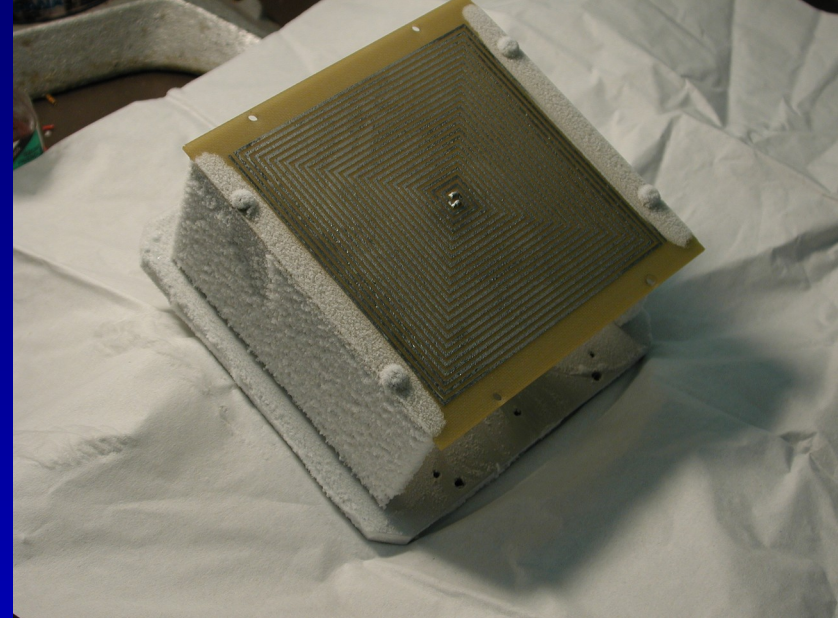


Antenna System Testing

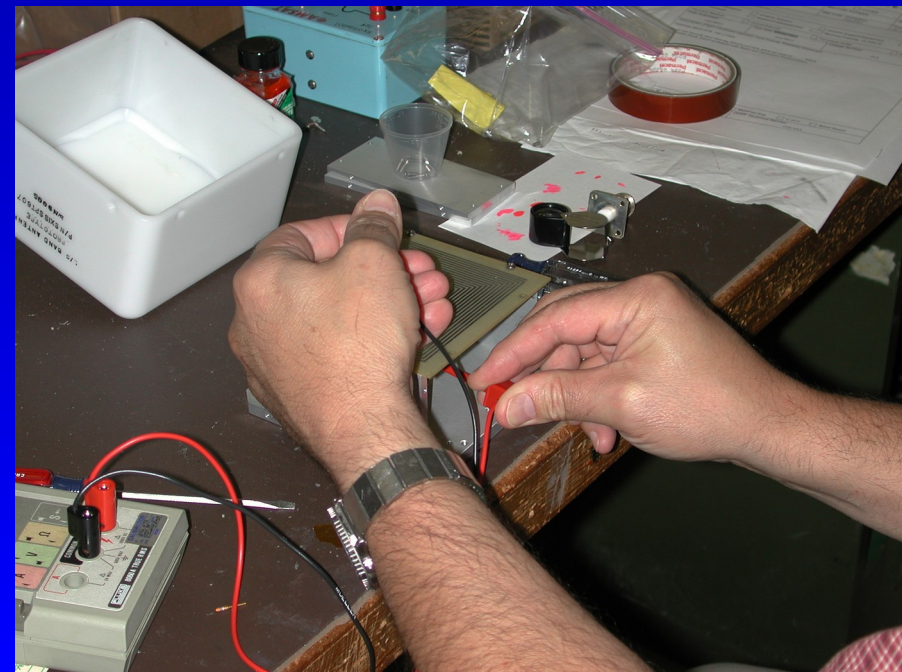
- Initial antenna system construction completed fall 1999
- Antennas patterns and SWR tested at GSFC (12/99 & 8/01)

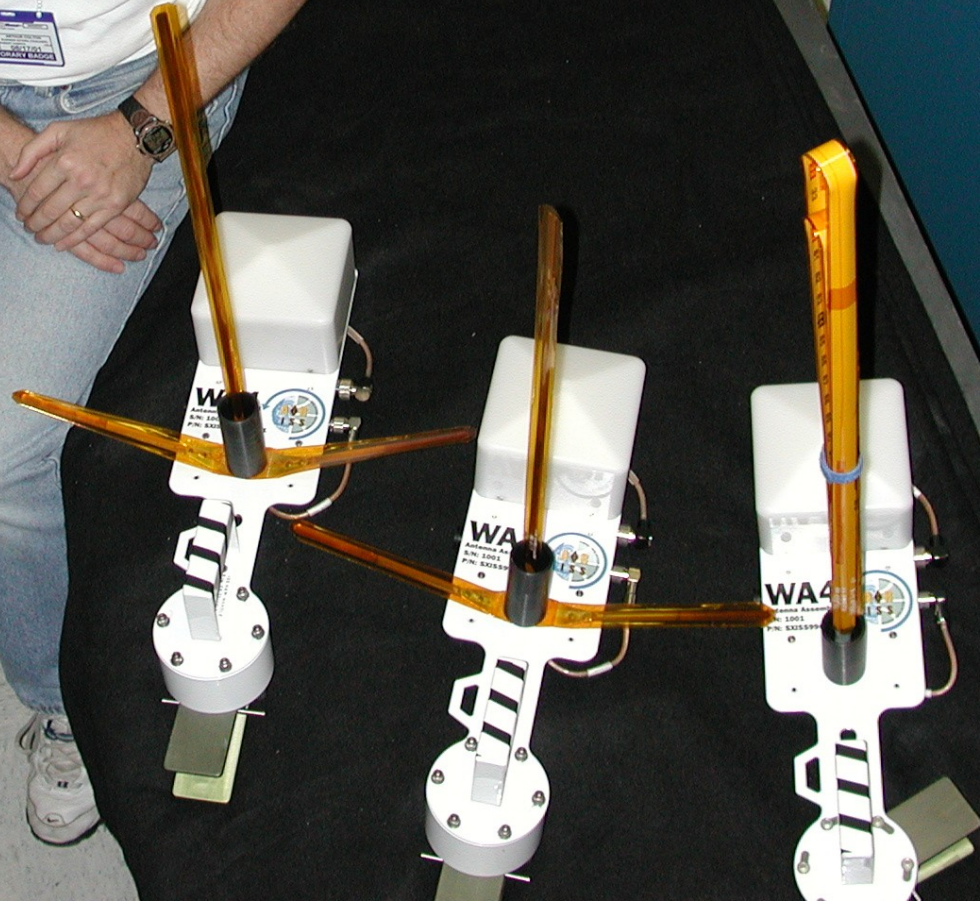
Antenna Testing at GSFC





Antenna System Thermal Testing







ГАРНИТ
HEADSET

ПРД
РТД

АДАПТЕР МОДУЛЬ
ADAPTER MODULE

00015188J

РАДИО СТ. ВСТРОИМ. ОБЩ.
AUX

ЕАР

AMSAT-NA

HEADSET EXTENSION CABLE

DO NOT REMOVE
EXTENSION CABLE
TO ADAPTER MODULE
IMPROPERLY

ANTENNA CABLE

DO NOT REMOVE
ANTENNA
CABLE OR CONNECTOR
TO THE MAIN TRANSDUCER

DO NOT REMOVE
CABLE OR CONNECTOR
TO THE MAIN TRANSDUCER

DO NOT REMOVE
CABLE OR CONNECTOR
TO THE MAIN TRANSDUCER

POWER CABLE

MPL2S3_G2

ISS HAM

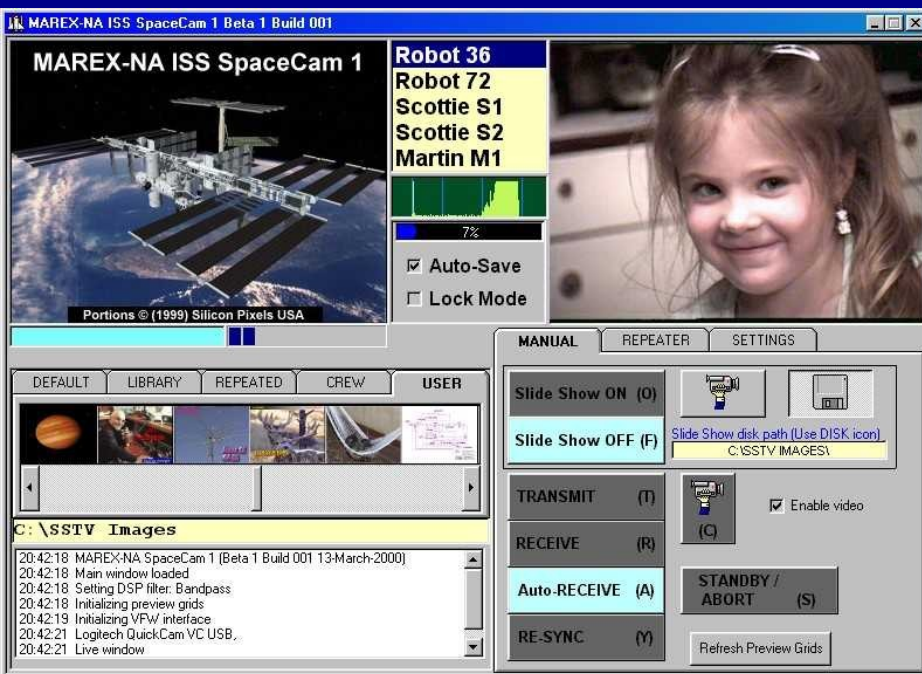
PCB 1 1 2 3 4 NABA

ISS HAM

Antenna Cable - 1
Headset Extension Cable - 1
ISS Ham 10.8V DC Power Cable - 1
Headset Assy - 1
Adapter Module - 1
ISS Ham Cable - 1
ISS Ham EVA Cable (WA1) - 1
Transceiver Cable - 1
ISS Ham EVA Cable (WA2) - 1
ISS Ham EVA Cable (WA3) - 1
ISS Ham RF Interface Cable - 1
ISS Ham EVA Cable (WA4) - 1

ISS HAM
G2

Next Up: SSTV

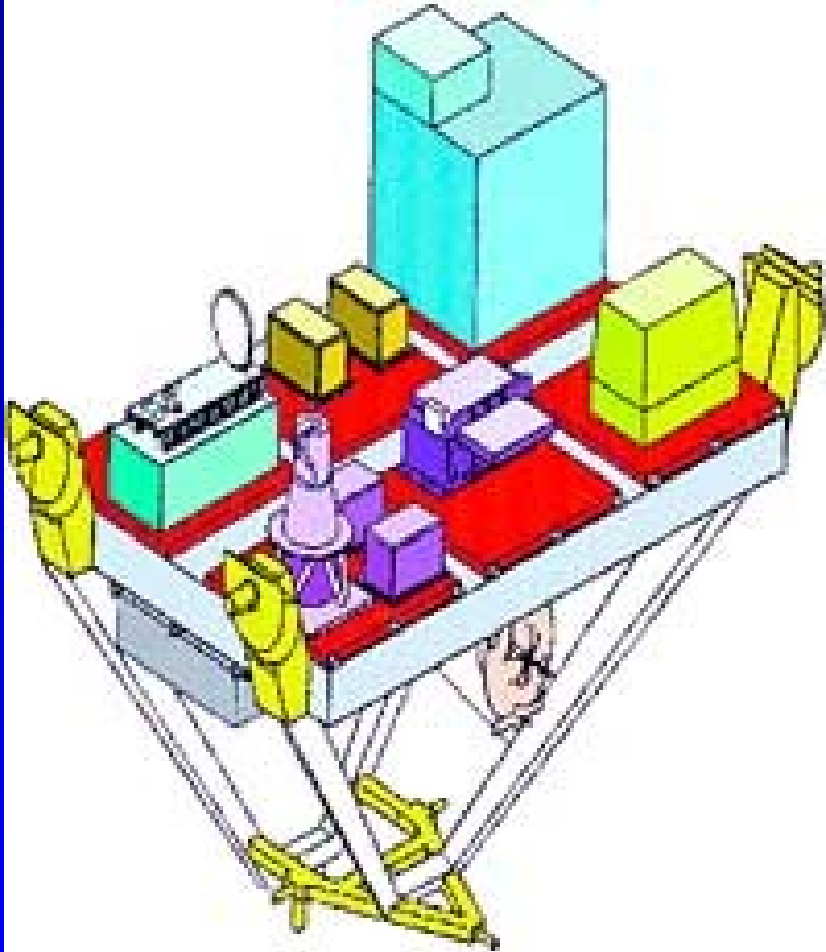


SpaceCam 1 H/W & S/W

Express Pallet Opportunity

- External payload mounted on ISS truss
- Prime, Earth viewing location
- 120 V DC and 28 V DC power available
- 1553, analog, and discrete interfaces available
- ARISS team discussing idea of soliciting “University/AMSAT Microsat” class payloads to fly as part of the amateur radio Express Pallet
- Future opportunities also available

EXPRESS Pallet

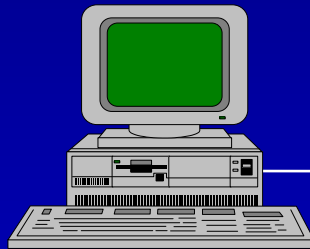


Operations

- Downlink:
 - Worldwide both voice & packet: 145.80
- Uplink:
 - Packet: 145.99
 - Region 1 voice: 145.20
 - Region 2 & 3 voice: 144.49
- Callsigns:
 - DL0ISS
 - RS0ISS
 - NA1ISS
- Crew Schedule
 - ~0700 to 1900 UTC
 - Off Saturday Noon to Sunday evening

DIRECT CONTACT INSTALLATION

PC WITH ORBIT
PREDICTION
PROGRAM
AND TRACKING
INTERFACE



ROTOR
CONTROL
UNIT

CIR. POL.
YAGI

AZ/EL
ROTOR

AC
POWER

12 V
POWER
SUPPLY

2 METER
TRANSCIVER

2 METER
AMPLIFIER
80-170 W

ANTENNA
PREAMP

PRIME STATION

UP
S

12 V
POWER
SUPPLY

2 METER
TRANSCIVER

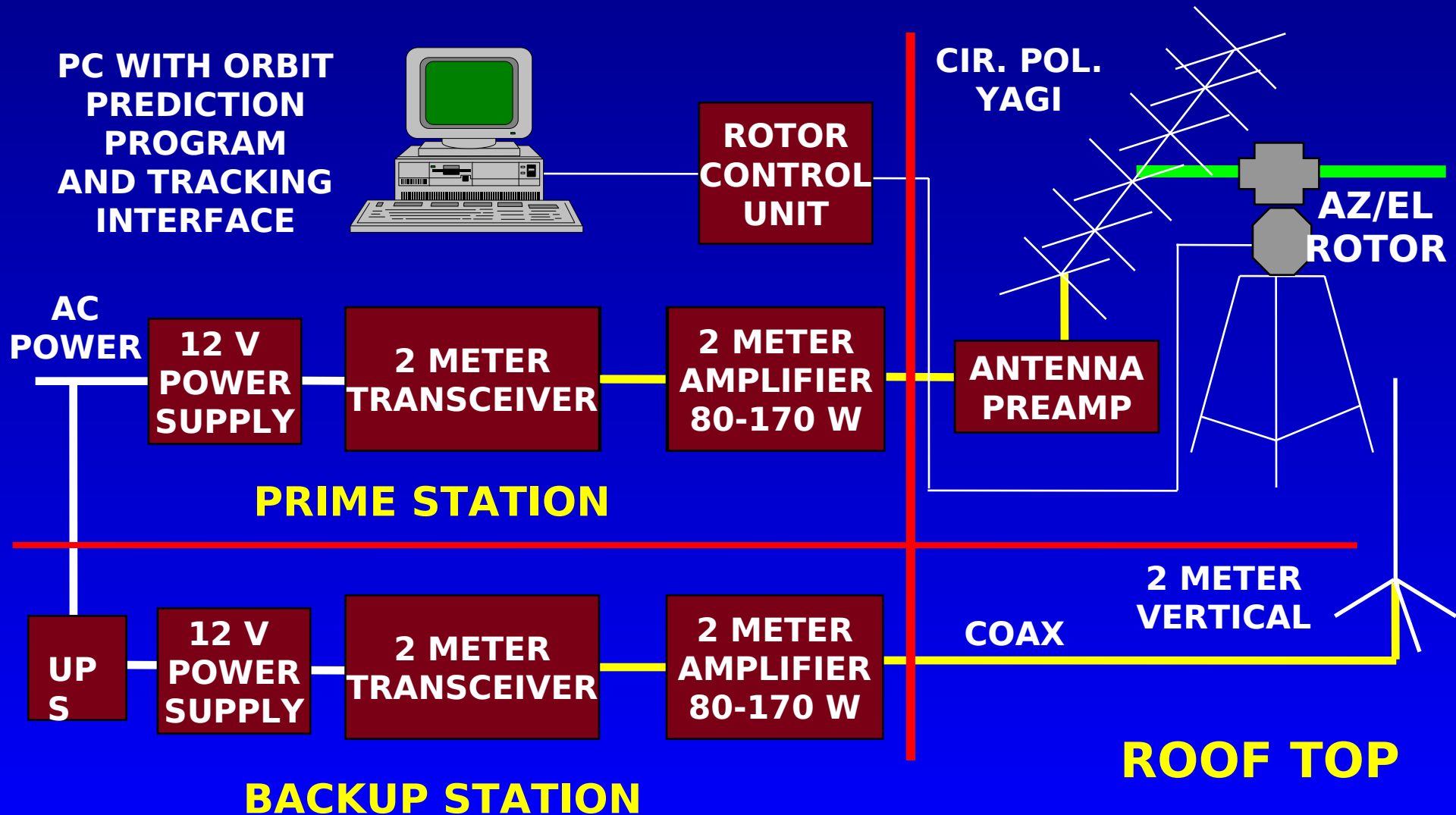
2 METER
AMPLIFIER
80-170 W

COAX

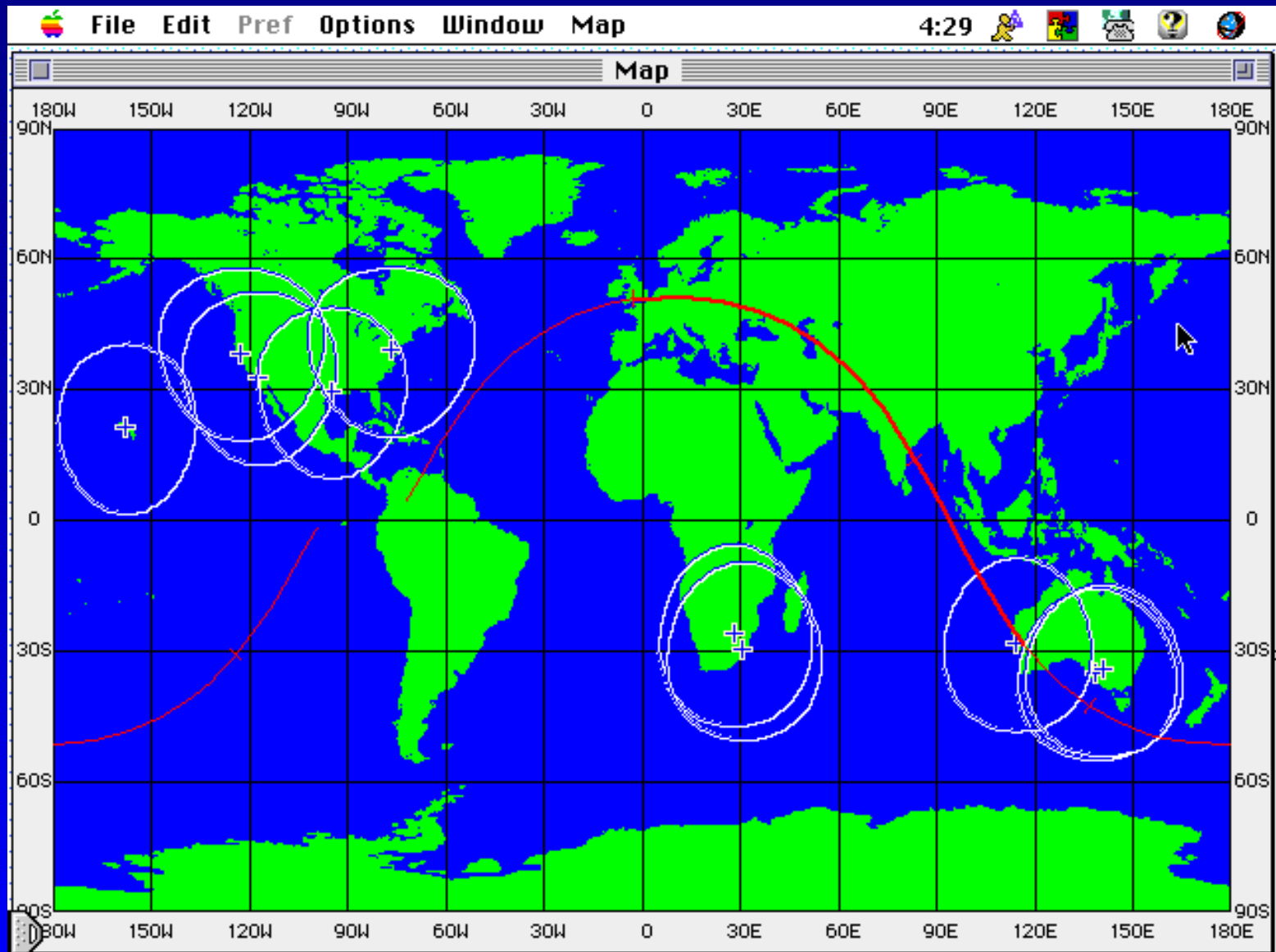
2 METER
VERTICAL

BACKUP STATION

ROOF TOP



Telebridge Network



Expedition 1 Crew

November 2, 2000-March 18, 2001



- 2m voice commissioned
- Packet turned on, no beacons
- Six schools in Canada and USA
- Some

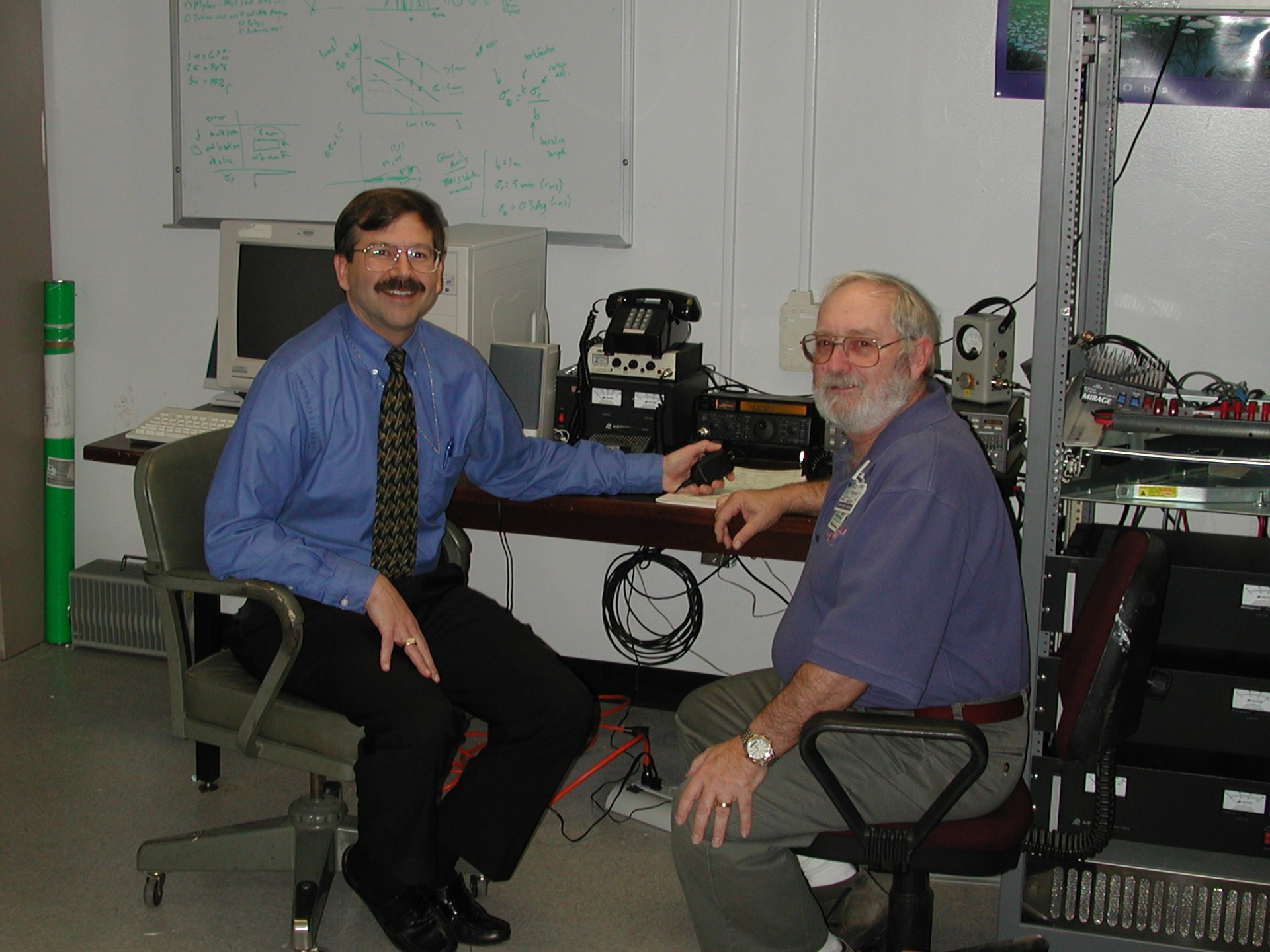
Sergei Krikalev, U5MIR Bill Shepherd, KD5GSL Yuri Gidzenko, General QSOs

- Crew very

U5MIR in the ISS ham shack









Exp 1 School group contacts



- Started December 21
- About once a week was the goal
- Seven total: 3 crew pick, 4 old
- Shuttle gaps were a big issue
- Lack of good orbital predictions, short notice of which pass will be supported

Expedition 2 Crew

March 19-August 12, 2001



- Numerous general QSOs
- Fourteen school events
- Packet debugging
- International schools
- Balanced ops
- Field day ops

Susan Helms, KC7NHZ, Yuri Usachev, UA9AD & Jim Voss



Susan Helms on the Air during Field Day



Field Day Results:

- 250 stations contacted
- 202 after dupes removed
- Bonus Points:
 - Solar Power
 - Off Commercial main
 - PR
- Total points: 1010



Tourists in Space



- Dennis Tito, KG6FZX, flight on ISS in May 2001
- ARISS telebridge support for family contacts
- Several, limited general QSOs



- Mark Shuttleworth in April, 2002
- Working on licensing
- School contacts planned
- Expect general QSOs

Expedition 3 Crew

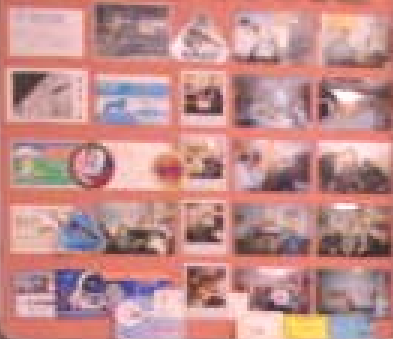
August 12, 2001-December 5, 2001



- Lots of schools
— 23 total
- Some general QSOs
- Packet enabled
- IMAX school contact
- No family passes requested
—iphone related

Svyatoslav Tyurin, Frank Culbertson, KD5OPQ, Vladimir Dezhurov

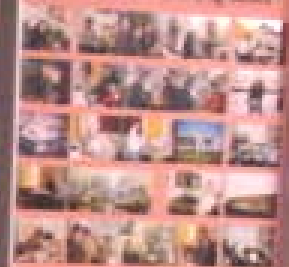
НАШИ ГОСТИ



ИНФОРМАЦИЯ



НАШИ БУДНИ

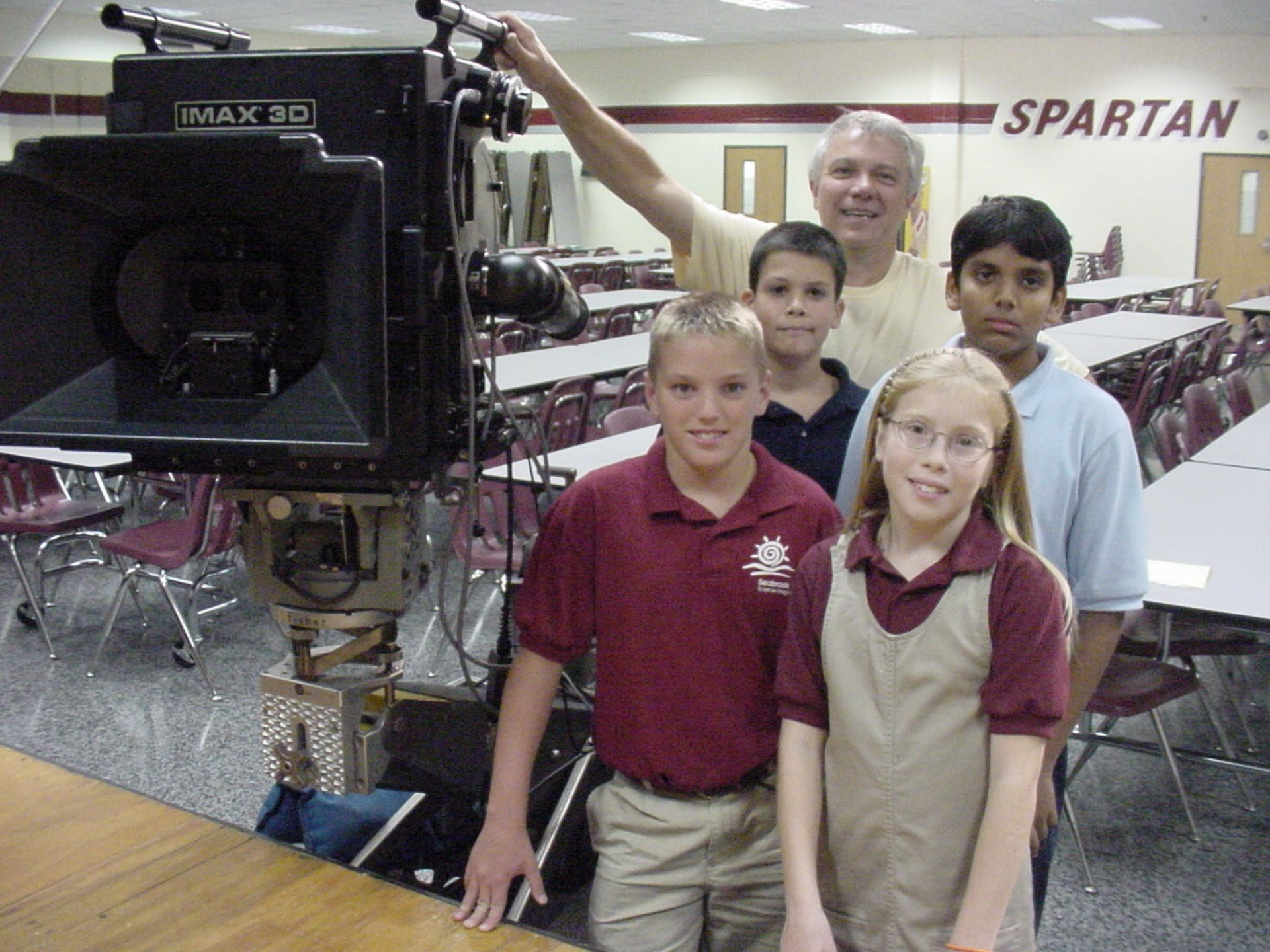


KD50PQ in the ISS ham shack



KD50PQ During JOTA





Expedition 4 Crew

December 5, 2001-Present



- EVAs--External antennas on Service Module
- 2nd packet module RS0ISS

Daniel Bursch, KC5PNU, Yury Onufrienko, KC5TIE, Carl Walz, KC5TIE

WA4 Antenna Ready for EVA



QSL Card



ARISS Information

[http://
ariss.gsfc.nasa.gov](http://ariss.gsfc.nasa.gov)

